



# **FedCASIC 2009**

**Learning from our mistakes:**

**Analysis of defects discovered using client side paradata**

The Bureau of Labor Statistics  
March 19, 2009

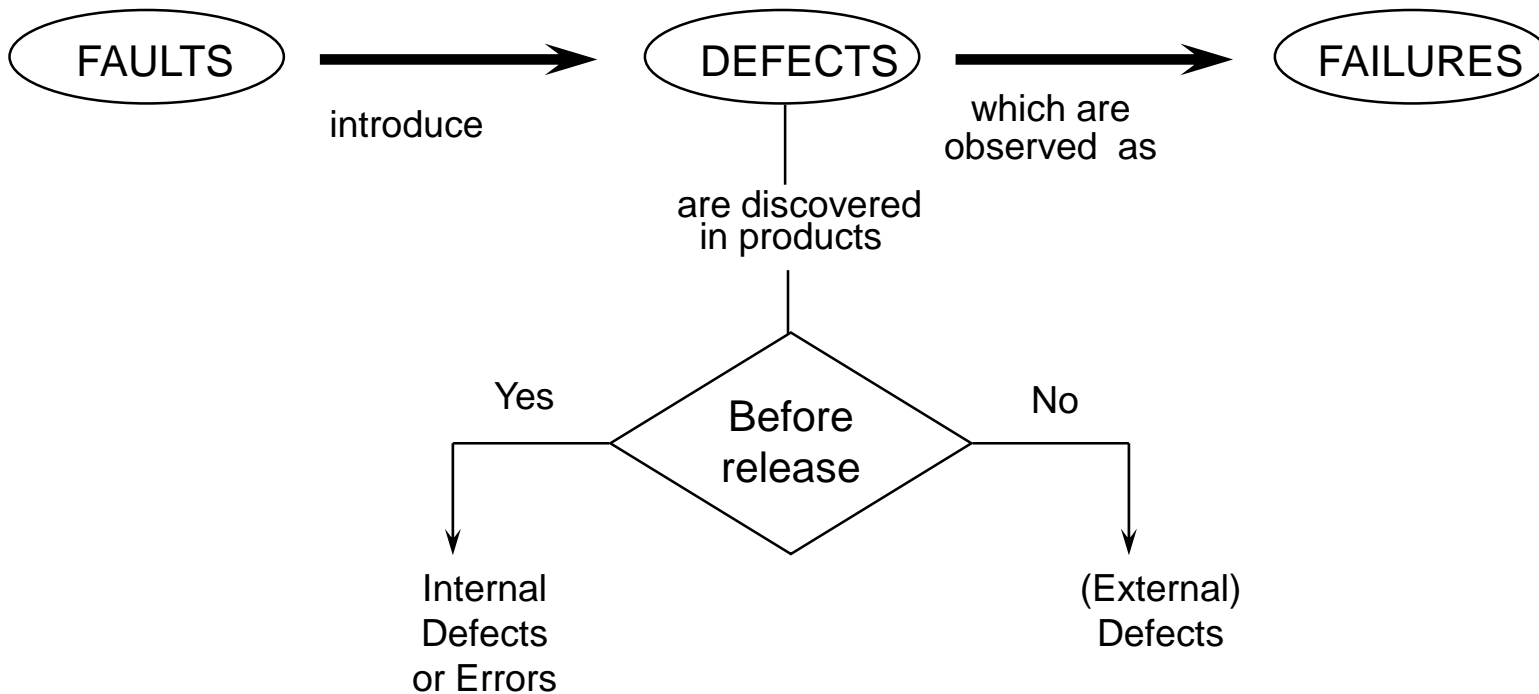
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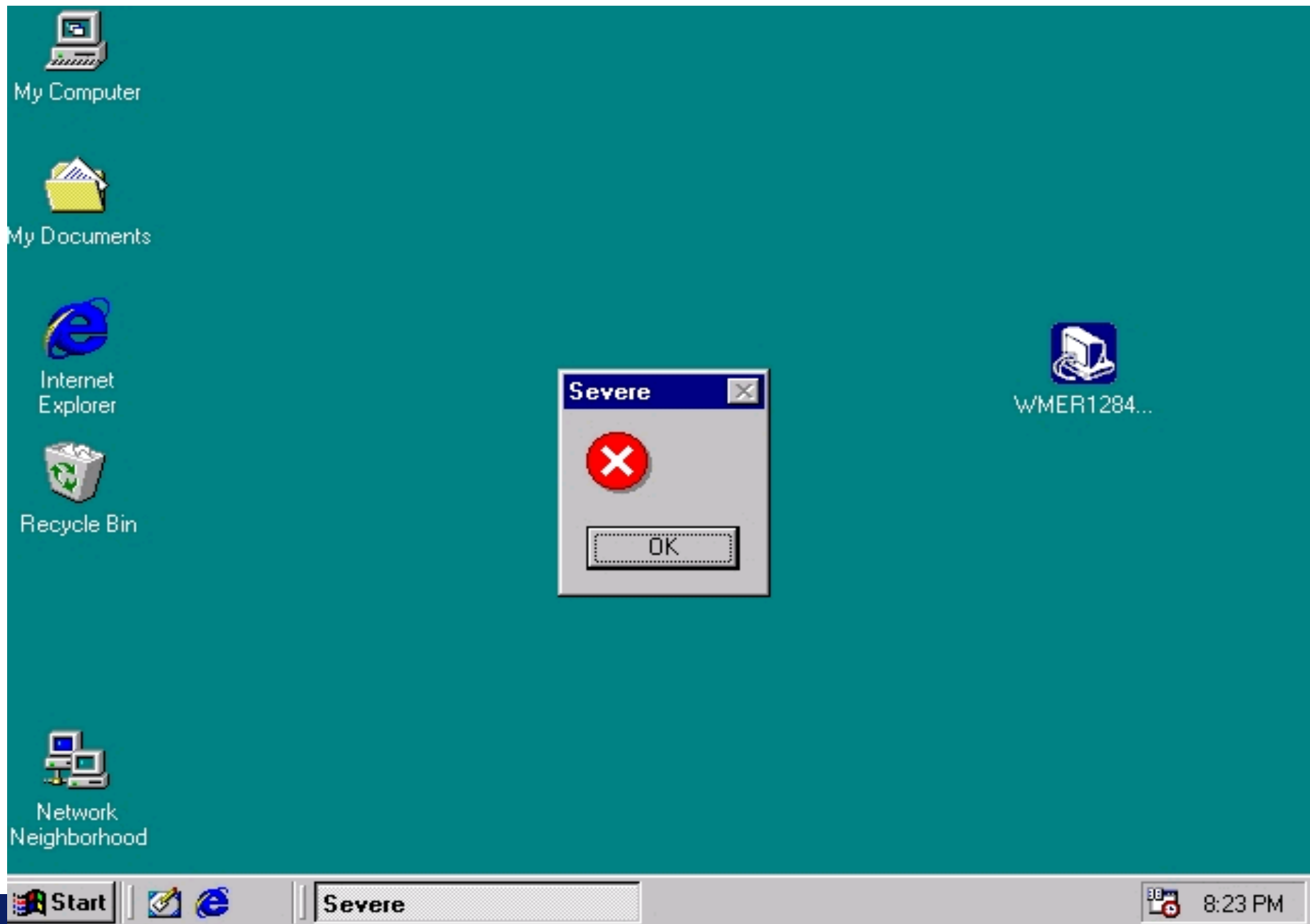
- ▶ Background
- ▶ Defect definition / Defect modeling
- ▶ Client side paradata – definitions and examples
- ▶ Uses of client side paradata for defect detection
- ▶ Measurements / Independent vs. Dependent variables
- ▶ Analysis methodology

## What is a defect?

- ▶ There is *considerable disagreement* about the definitions of defects, errors, faults and failures.
- ▶ Observed deviation of actual from expected behavior or features of a product

# Faults, Defects and Failures





# Defect Classifications and Models

- ▶ Classification schemes
  - **O**rtogonal **D**efect **C**lassification (IBM)
- ▶ Defect correction process models
  - **P**ersonal **S**oftware **P**rocess (Carnegie Mellon)
  - **CMMI** (Software Engineering Institute)
  - Six Sigma (Motorola)
- ▶ Predictive models
  - Multivariate Models
  - Bayesian Belief Networks (Hidden Markov model, etc)

# Background

- ▶ Mission is to improve the health and well-being of children
- ▶ Examine the effects of environmental influences on the health and development of 100,000 children across the United States, following them from before birth until age 21.
- ▶ Protocol: longitudinal cohort study of at least 100,000 mother-child pairs, with a time horizon of more than 20 years, and the ability to document specific life histories and related data.
- ▶ Led by a consortium of federal partners in collaboration with study centers across the country.

# UI defect profiling

- ▶ Project uses CAPI (Computer-Assisted Personal Interview) and ACASI (Audio Computer-Assisted Self-Interviews) instruments
- ▶ UI Widgets – used for data collection in instruments
- ▶ Widget effectiveness profiles
  - Time to enter
  - Number of tries



## Client side paradata

- ▶ “Client side paradata” is data about the interview collection process (separate from results data) that is collected on the interviewing hardware (as opposed to back at the data center) while the interview is taking place.
- ▶ It can include information such as the timing of questions answered, the UI method that was used, and the sequence of events that led to the final answer selection.

# Client side paradata (examples)

## ▶ Timing

- Measures how much time a data collector spent between UI actions, and total for each screen.
- Timing metrics for this screen, for example, would measure amount of time between each check box marked, and amount of time to hit next.

**CHITA**

In the 3 months before you knew you were pregnant, did you drink:

IF YES: On average, how many of these drinks did you have per day?

IF NO: RECORD "NA" FOR NUMBER OF DRINKS PER DAY.

TYPE OF PRODUCT	YES	NO	HOW MANY PER DAY	RF	DK
Caffeinated coffee?	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Caffeinated tea?	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Soda with caffeine? (Coke, Pepsi, Dr. Pepper, Mountain Dew)?	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>
Energy drinks with caffeine (Red Bull, Amp)?	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>

Navigation: Begin, Previous, Next, Fast Fwd, End

Status Bar: SID: 47970000000023 | R: 2307 | CARRIE-1 UNDERWOOD-1 | Self | Female | 21 years | HB1800: Drink coffee pre-pregnancy


# Client side paradata (examples)

## ▶ UI method

- Responses on data collection screens can either be selected by mouse (or stylus in the case of a tablet), or entered via a keyboard or other USB device.
- Spatial data is collected (x,y coordinates of mouse click) as well as key strokes to determine which method was used to answer certain questions.

What is today's date?

Use the keyboard to enter today's date, starting with the 2-digit **month**, next the 2-digit **day** and lastly the 4-digit **year**. Press 'NEXT' when you are done.



The image shows a user interface for entering a date. At the top, there is a question: "What is today's date?". Below the question is a horizontal line. Underneath the line, there is a blue instruction: "Use the keyboard to enter today's date, starting with the 2-digit **month**, next the 2-digit **day** and lastly the 4-digit **year**. Press 'NEXT' when you are done." Below the instruction is a numeric keypad with buttons for digits 1-0, a back arrow, and a forward slash. Above the keypad is a date template: "MM / MM / YYYY".

# Client side paradata (examples)

- ▶ Event sequence
  - Measures the order that information is captured on a particular screen.
  - Useful for determining which types of information are being collected first

The screenshot shows a web-based data collection interface with the following content:

**NAME:** What is the (next) oldest person's first name?

**AGE:** How old is (NAME)?

**GENDER:** Is (NAME) male or female?

**RELATIONSHIP:** Please refer to this card. What is (NAME'S) relationship to you?

**PROBE:** Now let me review the names that I have recorded. (READ NAMES FROM ROSTER.) Does this include all persons who usually stay here but are temporarily away on business, vacation, in the hospital, on full time active military duty, or students living temporarily away from home?

**NAME:** COLLECT UNIQUE NAME.  
**AGE:** ENTER "1" IF LESS THAN 1 YEAR.  
**GENDER:** IF KNOWN, SELECT GENDER WITHOUT ASKING.  
**RELATIONSHIP:** SHOW CARD DE1.  
MAKE SURE TO VERIFY ALL HOUSEHOLD MEMBERS HAVE BEEN ENTERED BEFORE MOVING ON TO THE NEXT SCREEN.

		NAME	AGE	GENDER	RELATIONSHIP
1	X	CARRIE-1	21	Female	SELF
2	X	Michelle	33	FEMALE	ROOMER, BOARDER
3	X	Sandra	27	FEMALE	UNMARRIED PARTNER
*					

Navigation buttons: Begin, Previous, Next, Fast Fwd, End

System status bar: SID: 47970000000023 | R: 2307 | CARRIE-1 UNDERWOOD-1 | Self | Female | 21 years | DE400-700

Windows taskbar: start, IN-2.15 Instrument, updated-grid - Paint, 2:23 PM

# Empirical uses of client side paradata for defect detection

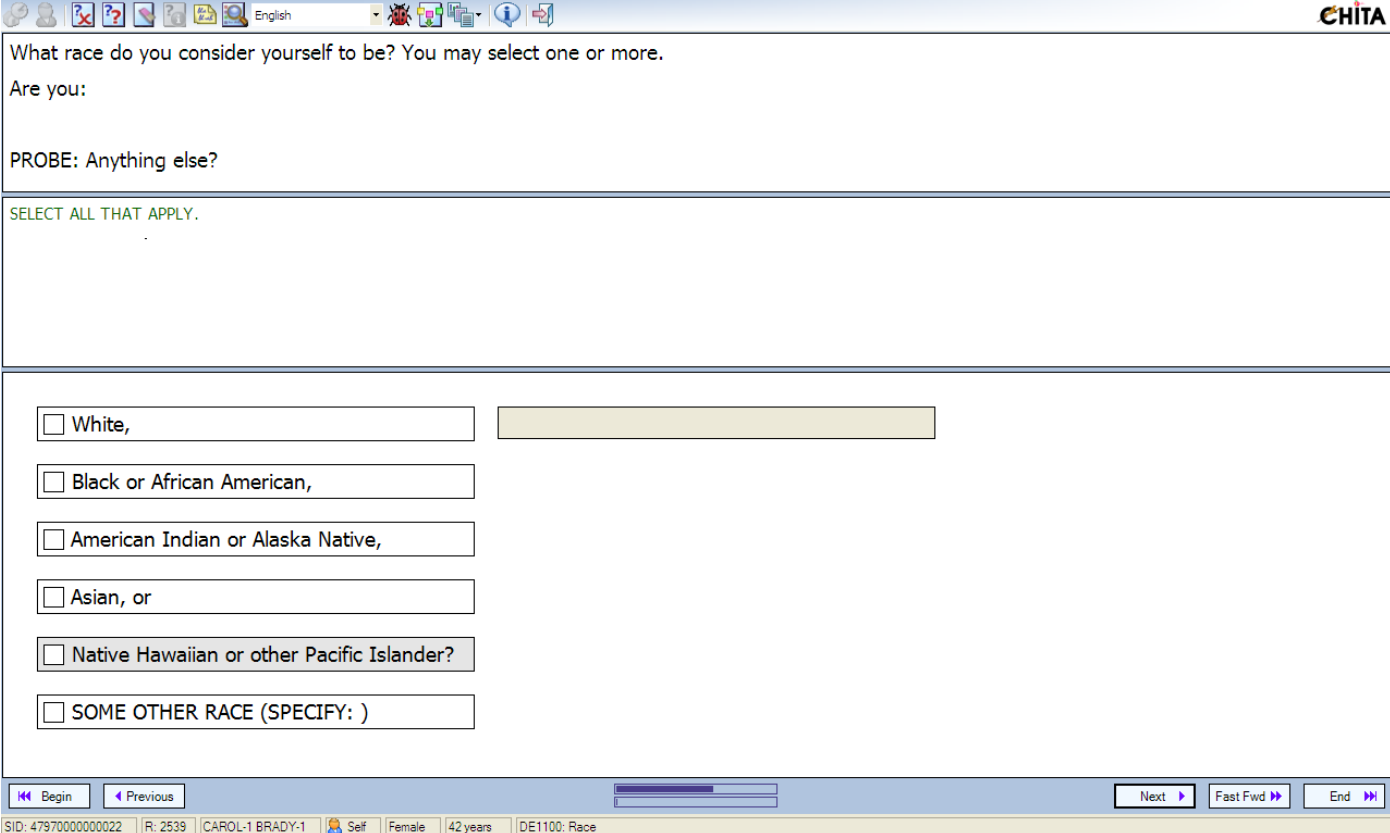
- ▶ Heerwegh findings
  - Data is higher quality when timing is discovered to be logarithmic (questions answered faster at the beginning, then pace slows) than exponential.
- ▶ Studying the effects of competing response formats example
  - Radio buttons vs. Drop down responses
- ▶ Question wording
- ▶ Effects of navigational aids
  - Visual layout
  - Mark all that apply vs. forced choice
  - Search box vs. Long lists

# Independent variables

- ▶ Question / UI layout
- ▶ Question wording
- ▶ Number / presentation of answer choices
- ▶ Data entry method

# Dependent variables

- ▶ Response latency
- ▶ Changes in answers
  - Adjacent changes (1 to 2, 3 to 4, etc.)
  - Reciprocal changes (1 to 5, etc.)



The screenshot shows a web browser window with the CHITA logo in the top right corner. The main content area contains the following text:

What race do you consider yourself to be? You may select one or more.  
Are you:

PROBE: Anything else?

SELECT ALL THAT APPLY.

Below this text are six checkboxes, each followed by a text input field:

- White,
- Black or African American,
- American Indian or Alaska Native,
- Asian, or
- Native Hawaiian or other Pacific Islander?
- SOME OTHER RACE (SPECIFY: )


At the bottom of the form, there are navigation buttons: "Begin", "Previous", "Next", "Fast Fwd", and "End". Below the buttons, a status bar displays the following information: "SID: 47970000000022 | R: 2539 | CAROL-1 BRADY-1 | Self | Female | 42 years | DE1100: Race".

# Defect Analysis

- ▶ Case Study #1
  - ACASI Date Widget

What is today's date?

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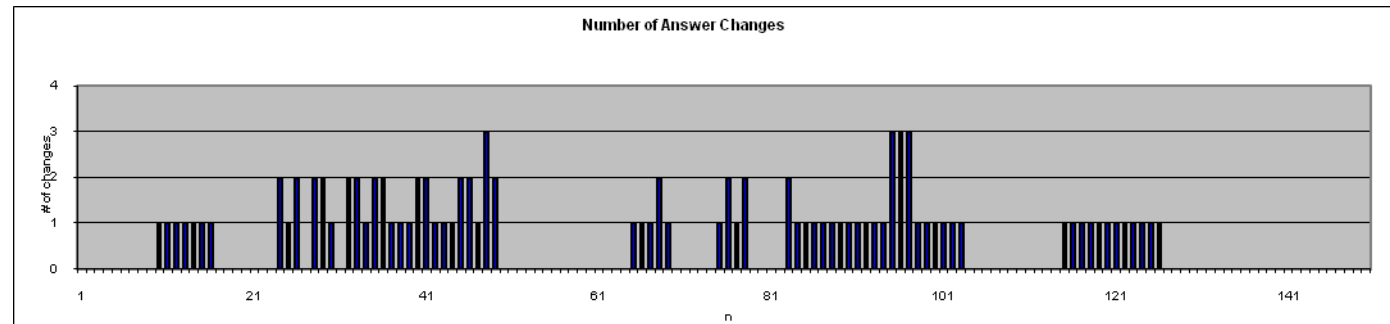


The image shows a screenshot of an ACASI (Audio Computer Aided Self-Interview) interface. At the top, there is a question: "What is today's date?". Below the question is a set of instructions: "Use the keyboard to enter today's date, starting with the 2-digit **month**, next the 2-digit **day** and lastly the 4-digit **year**. Press 'NEXT' when you are done." Below the instructions is a numeric keypad with a display area at the top. The display area shows a date format: two boxes for the month, a slash, two boxes for the day, a slash, and four boxes for the year. The keypad has buttons for digits 1-9, 0, a left arrow, and a forward slash. The keypad is highlighted with a blue border.

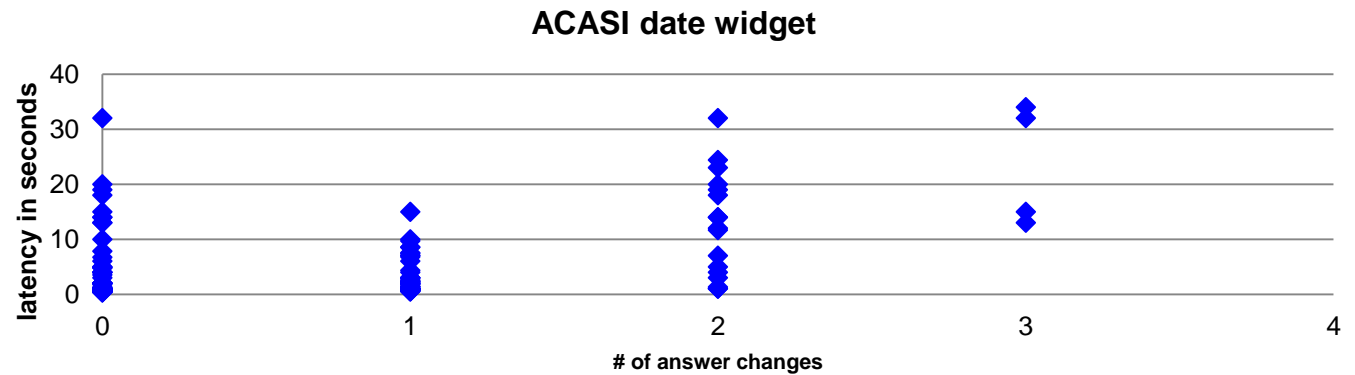


# Defect Analysis

- ▶ Example paradata that measures
  - Change in answers (Incidence of mistyped '\ ' in date widget)

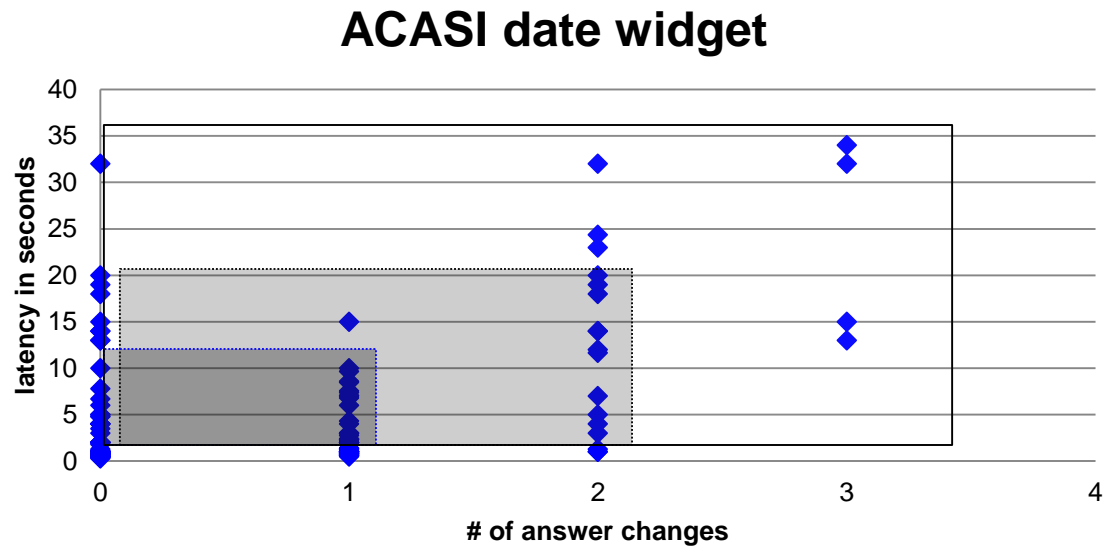


- Response Latency



# Defect Analysis

- ▶ Next steps
  - Create widget effectiveness profile



# Defect Analysis

## ▶ Next step...

- Grids
- Loops

The screenshot shows a software window titled "CHITA" with a menu bar and a toolbar. The main content area contains several sections of text and a table.

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Navigation buttons: Begin, Previous, Next, Fast Fwd, End. Status bar: SID: 47970000000023 | R: 2307 | CARRIE-1 UNDERWOOD-1 | Self | Female | 21 years | DE400-700. System tray: start, IN-2.15 Instrument, updated-grid - Paint, 2:23 PM.

## Next Steps

- ▶ Widget Effectiveness Profile
  - Create more widget effectiveness profiles
  - Can be applied to individual widgets
  - Can be applied to widgets in context (i.e. within specific instruments)
  - Can be applied to the application to include navigational considerations, etc.

## References

- ▶ *Prediction of Software Defects*; SASQAG March 2004; Neuendorf
- ▶ *Predicting Software Quality using Bayesian Belief Networks*; Martin Neil & Norman Fenton

**Questions?**